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# BULLETIN

OF THE

# TORREY BOTANICAL CLUB

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Vol. 51 No. 11

BULLETIN
OF THE
TORREY BOTANICAL CLUB

NOVEMBER, 1924

# Studies on the flora of northern South America—I.

H. A. Gleason

## Centropogon, Section Burmeisteroides

The genus *Burmeistera* Karst. is distinguished from *Centropogon* by the possession of green or greenish-yellow corollas of peculiar and characteristic shape and by the absence of terminal appendages from the two lower anthers. In *Centropogon*, these appendages are regularly present, and may consist either of a tuft of straight, separate, erect or reflexed hairs, or of a scale composed of accrescent hairs. The section *Burmeisteroides* is here constituted to include a group of species from the Andean region of northwestern South America with green or greenish corollas and with anther-appendages of villous or tomentose hairs. Differing from other species of *Centropogon* in these two features, they are also distinguished from *Burmeistera* by the longer and more slender corolla-tube, which is lobed to about the same depth on both upper and lower sides, and from most species of *Burmeistera* by the presence of conspicuous pubescence on the stem, foliage, flowers, or anthers.

The fruit is a dry, indehiscent berry, of the type prevalent in *Centropogon* and *Burmeistera*. This feature serves to differentiate the section from some species of *Siphocampylus* with green or yellowish flowers, such as *S. giganteus* and its relatives.

The older collections seem to include relatively few species of this section, but the recent explorations of Pennell, Killip, and Hazen have brought several undescribed species to light. The following are known to me from Colombia.

Sepals 18–50 mm. long, linear.
  Calyx gamosepalous for 10–15 mm. above the base, 45–50 mm. long; sepals glabrous on the back; anthers very sparsely hirsute on the connectives near the base..... *C. Andreanus.*

[The Bulletin for October (51: 409–442) was issued October 24, 1924.]

Calyx chorisepalous, or weakly gamosepalous for 1–2 mm. above the base; anthers densely hirsute on the connectives distally.
Sepals glabrous on the back; leaf-pubescence about equally dense on the surface and veins beneath..... *C. asservatus.*
Sepals villous on the back with flat crooked hairs; leaf-pubescence chiefly along the principal veins..... *C. Lehmanni.*
Sepals not more than 11 mm. long.
Sepals oblong, united below, erect and foliaceous above... *C. caldasensis.*
Sepals linear to linear-oblong, separate, erect or spreading.
Stem appressed-pubescent..... *C. Mutisianus.*
Stem pubescent with spreading hairs.
Sepals narrowly oblong, 2–3 mm. wide, thinly hirsute; leaves acuminate at base..... *C. variabilis.*
Sepals linear, 1–2 mm. wide, densely hirsute; leaves broadly cuneate to obtuse below.
Leaves acuminate, acute at the base; sepals erect, 8 mm. long..... *C. gravidus.*
Leaves obtuse, rounded at base; sepals spreading, 6 mm. long..... *C. breviflorus.*

**Centropogon Andreanus** n. sp. Stem 2 m. high, the upper portion hollow, finely striate, glabrous to barely puberulent; petioles 25–45 mm. long; leaf-blades broadly elliptic-oblong, the largest 85 mm. wide and 210 mm. long, cuneate at base, abruptly acuminate at apex, broadest at the middle, finely denticulate (about 6 teeth to 1 cm. of margin) with minute, black, triangular teeth 0.5 mm. high, pubescent on the upper surface with pale, flat, crooked and contorted hairs averaging 1 mm. in length, more crowded along the midvein, pubescent beneath with similar hairs, about 0.8 mm. long and located chiefly on the veins, ciliate with hairs of the same type but with dark purple or black septa, scattered along the margin and collected in tufts of 6–12 on every serration; peduncles stout, axillary, 11–14 cm. long, essentially glabrous below, pubescent distally with hairs like those of the leaves; hypanthium depressed-globose, when pressed 12–17 mm. wide by three-fourths as high, nearly glabrous, 10-ribbed, 5 ribs prolonged into sepalar midveins, 5 forking below each sinus and entering both sepals; sepals united for the basal 10–15 mm., the lobes linear-triangular, glabrous on the surface, faintly veined, 30–35 mm. long, finely callous-denticulate, ciliate with tufts of hairs on the teeth; corolla 80 mm. long, its tube 60 mm. long, glabrous, the lobes strongly depressed and falcate; anthers barely exserted, glabrous or barely pilose on the connectives below, the two lower anthers strongly bearded at the apex.

The herbarium of the Royal Botanic Garden at Kew contains two sheets, both collected by André under his number *2799*,

and agreeing precisely in every detail. One is labeled "Rio dos Brazos prope Popayan, 19 April 1876," the other "ad decliv. occident. mont. igniv. Corazon And. Ecuad. 3400 m., 10 Jun. 1876." The latter is the type, and bears a reference to the collector's illustration tab. CLXXX, but unfortunately plate CLXXXII is mounted with the plant.

**Centropogon asservatus** n. sp. A tall herb; stems hollow above, faintly angled, puberulent above, becoming glabrous and somewhat verrucose in age; internodes 2–3 cm. long; leaves thin, membranous, dull-green, oblong-elliptic, 8–11 cm. long, 2–3 cm. wide, acuminate, gradually cuneate at base into a narrowly winged petiole 1 cm. long, finely, sharply, and irregularly dentate (about 9 teeth per centimeter of margin) with triangular, callously mucronate teeth 0.4–1 mm. high, sparsely puberulent above with short, contorted, dark purple hairs, thinly pubescent on the venation beneath with flat, crooked, pale brown hairs, thinly ciliate with crooked hairs with black septa, veins not prominent, reticulate beneath; peduncles from the upper axils, 8–12 cm. long, thinly puberulent to nearly glabrous, erect or ascending; hypanthium obconic, 16–20 mm. high, 9–11 mm. wide at the summit when pressed, faintly nerved, nearly glabrous; sepals erect, narrowly linear above a narrowly triangular dilated base, about 5 cm. long, glabrous on the surface, remotely and minutely callous-denticulate, sparsely ciliate with crooked hairs with black septa; corolla-tube 28 mm. long, glabrous, gradually narrowed to the middle, thence dilated to the throat, the lobes narrowly triangular-falcate, depressed, 20 mm. long; filaments 10 mm. longer than the corolla-tube, subtomentose above; anthers 13 mm. long, subtomentose with white hairs below, hirsute with erect brown hairs on the connectives, the two lower strongly bearded at the apex; fruit a dry berry, ellipsoid, 3 cm. long, surmounted by the persistent sepals.

Type, *Pennell 927*, collected 3–6 Aug. 1917, in forests on the Rio Balsillas, Dept. Huila, Colombia, altitude 2000–2100 m., and deposited in the herbarium of the New York Botanical Garden. Other specimens are *Pennell 960* and *601*, Cordillera Oriental, east of Neiva, Dept. Huila, 1–8 Aug. 1917. Of these the latter has broader leaves, about three times as long as wide, with sepals 40 mm. long.

CENTROPOGON LEHMANNI Zahlbr. Four numbers in the herbarium of the New York Botanical Garden are referred to this species, although differing in some unimportant respects from each other and from the type. In *Lehmann 529*, without

data, and *882*, forests of Popayán, 1700–2500 m., the leaf-blades are more than twice as long as broad and sharply cuneate at base and the thinly villous sepals are about 30 mm. long. In *Pennell and Killip 8087*, Rio Ortega, Dept. El Cauca, Colombia, 2 July 1922, and *Pennell 10,279*, Apia, Dept. Caldas, 4, 5 Sept. 1922, the leaf-blades are less than twice as long as wide and the densely villous sepals are only 20 mm. long. Zahlbruckner cited two sheets, *Lehmann 4754* and *Triana 1569*. I have seen the latter in the herbarium of the Museum at Paris and find it essentially intermediate between the two forms mentioned above.

**Centropogon caldasensis** n. sp. Stem herbaceous, angled, hollow, puberulent above, becoming glabrous below, bearing numerous short axillary leafy branches; petioles 20–25 mm. long, slender, minutely puberulent; leaf-blades membranous, bright green, ovate-lanceolate, 45–65 mm. long, 20–25 mm. wide, subacuminate, rounded at base, shallowly repand to subentire (4–6 teeth per centimeter of margin), glabrous above, thinly pubescent on the veins beneath, the veinlets obscurely reticulate; peduncles ascending from the upper axils, 4 cm. long, conspicuously ridged, thinly puberulent, with two basal linear bracts 8 mm. long; hypanthium obconic, 9 mm. high, 4 mm. wide at the summit when pressed, thinly puberulent, faintly ribbed; sepals 10 mm. long, united for the basal 2 mm., the lobes oblong, erect, somewhat foliaceous, short-acuminate, many-nerved, irregularly contorted along the margin or serrulate, essentially glabrous, separated by narrow acute sinuses; corolla-tube slender, 14 mm. long, puberulent, the lobes linear-falcate, depressed, 7 mm. long; filaments glabrous, equaling the petals; anther-tube strongly depressed, short and stout, 4 mm. long, glabrous, the two lower anthers densely villous at the apex.

Type, *Pennell 10,322*, collected 7–11 Sept. 1922, along the Rio San Rafael, below Cerro Tatama, altitude 2200–2400 m., Dept. Caldas, Colombia, and deposited in the herbarium of the New York Botanical Garden.

**Centropogon Mutisianus** (H.B.K.) n. comb. (*Lobelia Mutisiana* H.B.K.) The distinction between this and related species stated in the key above has been drawn from the type specimen in the herbarium of the Museum at Paris.

**Centropogon variabilis** n. sp. Stem herbaceous, strongly angled, densely pubescent or subtomentose with sordid brown hairs above, becoming glabrate with age, the internodes 1–2 cm. long; petioles angled, densely pubescent, 10–25 mm. long; leaf-blades broadly elliptic, about 9 by 18 cm., thin and mem-

branous, bright green, abruptly acuminate, cuneate or acute at base, coarsely and irregularly repand, the larger teeth triangular, 2–4 mm. high and 10–20 mm. apart, the intermediate teeth much smaller, thinly pubescent along the midvein and laterals above and likewise on the surface when young, thinly pilose on the surface and densely so the veins beneath, the hairs straight, appressed, 0.4 mm. long, forming conspicuous belts along the veins; peduncles from the upper axils, 5 cm. long, thinly pubescent; hypanthium short-cylindric, 9 mm. high, 7 mm. wide when pressed, puberulent; sepals triangular, 6 mm. long, 2.5 mm. wide at the base, pubescent on both sides, with about three pairs of low callous teeth, separated by narrow rounded sinuses; corolla puberulent, the tube 25 mm. long, straight, slender, the lobes linear-oblong, falcate, depressed; filaments glabrous, included; anther-tube 8 mm. long, subtomentose on the sutures, the two lower anthers villous at the apex.

Type, *Pennell 10,734*, collected 18, 19 Sept. 1922, at Buenos Aires, north of Supia, Dept. Caldas, Colombia, altitude 2000–2200 m., and deposited in the herbarium of the New York Botanical Garden. Four other sheets are also referred here, which differ so much from the type as to suggest the specific name *variabilis*. These differences do not appear to warrant the recognition of additional species but indicate merely a considerable degree of variability. In *Pennell 3409*, Libano, Dept. Tolima, 26–29 Dec. 1917, the leaves are proportionately narrower and the serrations lower; in *Pennell 10,324*, Rio San Rafael, below Cerro Tatama, Dept. Caldas, 7–11 Sept. 1922, the leaves are smaller, thicker, and blunter; in *Pennell 10,325*, same place and date, the small leaves are almost obovate, while *Pennell 4397*, Cascada Chorron, south of Antizales, Dept. Bolivar, 25 Feb. 1918, is a fragmentary specimen without flowers.

I have not seen the type of Karsten's *Burmeistera tomentosula*, which was imperfectly described. It may be similar to our species.

**Centropogon gravidus** n. sp. Stem herbaceous, hollow, strongly angled, densely pubescent with straight spreading hairs with black septa; petioles stout, densely pubescent, 10–13 mm. long; leaf-blades elliptic-oblong, firm, dull-green, 13–23 cm. long, 3–7 cm. wide, abruptly acuminate to long-acuminate, tapering to an acute or cuneate base, coarsely, sharply, and irregularly dentate, especially above the middle, with triangular teeth as much as 5 mm. long (about 2 teeth per centimeter of margin) to subentire, pubescent above with straight, stiff,

brown hairs about 0.5 mm. long, especially along the midvein, pubescent with similar hairs below, especially along the veins, where they form conspicuous belts of pubescence; peduncles numerous from the upper axils, ascending, 5–7 cm. long, pubescent like the stem, the bracts linear, 3 mm. long, deciduous; hypanthium short-cylindric, 9 mm. long, 7 mm. wide when pressed, sparsely pubescent; sepals erect, 8 mm. long, narrowly triangular, acute, irregularly serrate with 3 or 4 pairs of teeth, thinly hirsute, conspicuously ciliate with tufts of hairs with dark septa; corolla sparsely pubescent below, becoming densely so toward the apex of the lobes, the tube 27 mm. long, stout, the lobes broadly linear-falcate, depressed; filaments included, glabrous; anther-tube stout, somewhat curved, 8 mm. long, thinly pubescent, especially at the apex, the two lower anthers villous at the summit.

Type, *Killip & Hazen 11,122*, collected 9 Sept. 1922, at La Cumbre, Dept. El Valle, Colombia, altitude 1700–2100 m., and deposited in the herbarium of the New York Botanical Garden. Other collections are *Pennell 4398*, Cascada Chorron, south of Antizales, Dept. Bolivar, 25 Feb. 1918, *Pennell 5723*, La Cumbre, Dept. El Valle, 14–19 May, 1922, and *Killip 5921*, La Cumbre, 21–25 May 1922.

**Centropogon breviflorus** n. sp. Stem shrubby, climbing, angled, apparently solid, densely pubescent or subtomentose with septate hairs; petioles densely pubescent, stout, 3 mm. long; leaf-blades firm, spreading, dull-green or brown-green, elliptic, 5–8.5 cm. long, 3.5–4.5 cm. wide, obtuse, rounded at base, entire or barely repand, thinly puberulent above with short curved hairs, especially on the midvein, closely pubescent on the surface and veins beneath with short brown hairs, and hirsute on the midvein with longer, straight, spreading hairs; peduncles from the upper axils, stout, 2–3 cm. long, pubescent like the stem; hypanthium short-cylindric, 7 mm. high, 8 mm. wide when pressed, densely pubescent like the peduncle, especially at the base; sepals spreading, narrowly triangular-linear, 6 mm. long, somewhat involute, densely hirsute and ciliate with straight brown hairs; corolla 20 mm. long, densely pubescent with septate hairs, the tube 15 mm. long, the lobes linear-falcate, depressed, glabrous along the margin; filaments included, glabrous; anther-tube black, 5 mm. long, thinly and sparsely pubescent, the two lower anthers villous at the tip.

Type, *Pennell 7545*, collected 29, 30 June 1922, on Mount El Trueno, Dept. El Cauca, Colombia, altitude 2700–3000 m., and deposited in the herbarium of the New York Botanical Garden.

# Crown gall on Bryophyllum calycinum*

MICHAEL LEVINE

(WITH PLATE 10)

In a paper on the effect of inoculations of *Bacterium tumefaciens* into the notches and midveins of detached leaves of *Bryophyllum calycinum* planted in moist sand, the present writer (Levine 1919) pointed out that in a great majority of cases the notches produced only crown galls of the common globular type without indications of leafy shoots. The inoculations into a midvein, however, invariably resulted in the development of only a crown gall. Inoculations of the crown gall organism alongside of the notches in these detached leaves yielded occasionally a crown gall with a dwarfed leafy shoot. Control leaves set out under similar conditions resulted in large and vigorously growing shoots in the time that it took the stunted leafy shoot and crown gall to develop.

Inoculations of *Bacterium tumefaciens* into the region near the axillary buds of the stem caused the formation of a crown gall and a poorly developed axillary bud. Frequently the crown gall formed over its surface a number of leaflets. The axillary bud failed entirely in its development.

Smith (1921) inoculated *Bacterium tumefaciens* into the notches of undetached leaves of *Bryophyllum calycinum*, which, he states, resulted in the development of shoots in the notches. He contends that *Bacterium tumefaciens* stimulated the development of these buds. Inoculations of the axillary bud of the stem with the same organism resulted in the two types of leafy crown galls described by me (Levine 1923). Smith's results confirm my supposition that *Bryophyllum* has many totipotent cells. He fails, however, to show that these cells may be stimulated by *Bacterium tumefaciens* to form "embryomata" or leafy shoots in any region other than that where dormant buds are known to exist.

In a later paper (Levine 1923) the writer reported studies on the effects of inoculations of *Bacterium tumefaciens* on the tobacco

* Contribution from the Cancer Laboratory, Montefiore Hospital, New York.

plant, which forms leafy crown galls readily. Three distinct types of crown galls appear here also, namely, the common globular type, the differentiated globular type which forms small and slowly growing leaflets over its surface, and the axillary leafy crown gall which consists of a crown gall and a poorly developed axillary bud. The stimulus to growth of this type of crown gall is not the direct result of *B. tumefaciens*, but is due rather to a mechanical interference with the food supply incident to the development of the mass of crown gall tissue.

In a recent paper (Levine 1924) the author reports further observations on rubber trees, which were studied for a period of over four years. The results substantiate his earlier studies made on the *Bryophyllum* and the tobacco plants.

De Vries (1891), Goebel (1908) and Loeb (1915, 1917, 1918) have claimed that the development of shoots in the notches of the *Bryophyllum* leaf was inhibited by the presence of the main root or regenerated roots on the stem. These authors further claimed that the organic separation of the leaf from the rooted part of the plant acts as a stimulus upon the leaf and induces growth of the buds in the notches. Loeb (1915) contends that this is not the only factor involved. He states that a piece of stem, even if it does not form any roots but only a shoot, will prevent or greatly delay the growth of the notches of a leaf connected with it.

Miss Braun (1918) pointed out that leaves of *Bryophyllum* attached to the plant were capable of producing leaves and roots at their notches. Loeb (1918 *b*) claims that this development occurs only in sick plants. He contends that the recumbent position of the stem acts as a partial block to normal transportation of fluids, and that such sick and bent stems behave to all purposes like isolated pieces of stems, the leaves of which will give rise to shoots. Reed (1923) holds that, while the stem and roots of the plant do not influence the development of the buds in the leaf notches, conditions, such as the absence of light, and the abundance of very moist air or water, do have such an effect.

The present report deals with further observations on the effect of inoculations of *Bacterium tumefaciens* into the notches of leaves of *Bryophyllum*. I showed that in leaves which were stimulated to shoot development by being cut from the stem and planted in moist sand, relatively few leafy crown galls

developed after inoculation. It has seemed to me to be desirable to determine the effects of inoculation of the notches of these leaves undetached from the mother plant and to determine the frequency of the leafy crown galls thus formed, as compared to the number of the common globular types that appear. I have found in my cultures what appear to be mature and healthy *Bryophyllum* plants which developed leafy shoots at their notches. The number of shoots formed on these leaves resulting from an apparently unknown condition was compared with the number of leafy shoots resulting after the inoculation with *Bacterium tumefaciens*. Both plants were grown under similar conditions. Up to the present the differentiated globular crown gall with leaflets on its surface has not been observed at the margin of *Bryophyllum* leaves.

## MATERIAL AND OBSERVATIONS

In the present experiment twelve young *Bryophyllum calycinum* plants were set out on benches in the greenhouses at Columbia University. These were rapidly growing plants with numerous leaves of all ages, although none were very old. Only the young leaves in the middle portion of the plant were used. Five to ten of these leaves in each plant were selected. The inoculations were made by piercing the notches of the middle portion of the leaves where shoots most frequently develop (Loeb 1918 *a*) with a needle dipped into a sub-culture of the hop strain of *Bacterium tumefaciens*. The inoculations were made on September 25, 1923. The leaves were carefully labeled. They were examined from time to time and all changes were noted. On April 21, 1924 it was observed that the inoculated leaves were becoming old and dying. The leaves were detached and the numbers and kinds of crown galls were recorded.

FIG. 1 represents a crown gall with four leafy shoots resulting from the inoculation of *Bacterium tumefaciens* into the notches of the leaf. It is quite clear from this photograph that where the inoculations were made globular crown galls developed, with the exception of one case shown here, where the bud at the notch developed into four shoots. At the bases of these shoots a large crown gall is to be seen. Such leafy crown galls are like those that sometimes develop when the axillary bud of the stem is inoculated with *B. tumefaciens*, such as shown by

Smith (1921, *f. 101*) and in my own studies on tobacco (Levine 1923, *f. 13, 14*). To test whether or not these shoots are diseased or only stunted, owing to interference with their water and other food supplies by the crown gall tissue, I removed them from the leaf. All parts of the mother leaf were trimmed away from the crown gall and the leafy shoots attached to it. No roots were at this time visible. The adventitious leafy crown gall was then planted in a pot. FIG. 2 represents this leafy crown gall two months later. It shows the leaf and stem portion of the crown gall developed into an apparently normal plant with four stems, at the bases of which may still be seen the globular portion of the crown gall. Long, fibrous roots have developed not only from the surface of the crown gall tissue but also from the lower nodes of the stems. The plants grew rapidly and are still growing in the experimental garden at Montefiore Hospital.

The other types of crown gall are represented in FIG. 3—at *a*, the globular type, and at *b*, the differentiated leafy crown gall. The crown gall at *b* first appeared as a mass of globular tissue. Later the leaves began to make their appearance, as described previously in my studies on tobacco. These leafy shoots are not due to injury of the dormant bud at the notch of the leaf. When the bud is cut into a number of parts at the time of inoculation, each part develops into a shoot, as I have pointed out and figured before (Levine 1923, *f. 16*). In the present instance, as in the case of Smith's FIG. 103 (1921) the crown gall cells became differentiated and developed into the small leaves and stems shown there. Under moist atmospheric conditions roots may also appear. It is barely possible that five pricks of the inoculating needle will cut up the bud into fifty or more parts which develop into small leaves frequently sessile.

Smith (1921) believes these leafy crown galls are embryomata comparable to embryomata in human cancer. He considers the internal differentiated tissues of the crown gall comparable to the stroma of cancer. The stroma of human and of animal cancers arises from muscle, nerve, blood vessel, and other connective tissue elements, which occur in the region of the neoplasm. By resumption of growth of these tissues the stroma is formed. Vessels and tracheids in plants once formed cannot resume

growth. The meristematic tissue which forms vessels and tracheids is stimulated to proliferate through the agency of the crown gall organism. These cells, on differentiation, form isolated parts of a poorly organized fibro-vascular system. In benign crown galls there is frequently a considerable increase in the thickness of the wood. This is likewise due to stimulated meristematic tissue with subsequent differentiation. The cortical cells are capable of responding to the stimulus to divide. They eventually become mature cortical cells.

## FREQUENCY OF LEAFY CROWN GALLS

The following table shows the number of crown galls that are formed at the notches of leaves of *Bryophyllum* when inoculated with *Bacterium tumefaciens*. The fourth column shows the number of leafy crown galls formed when the notches of the longitudinal half of the leaf are inoculated. The figures in the third column do not include the leafy crown galls.

TABLE 1

RESULTS OF INOCULATIONS OF BACTERIUM TUMEFACIENS INTO THE NOTCHES OF LEAVES OF BRYOPHYLLUM CALYCINUM.

| No. of leaves | No. of globular crown galls per long half of leaf | Total | No. of leafy crown galls |
|---|---|---|---|
| 17 | 4 | 68 | 13 |
| 9 | 6 | 54 | 4 |
| 9 | 5 | 45 | 8 |
| 8 | 3 | 24 | 4 |
| 3 | 2 | 6 | 0 |
| 2 | 1 | 2 | 2 |
| 48 | | 199 | 31 |

An analysis of the results obtained from these inoculations shows that 17 leaves produced 68 globular crown galls. Seven of these leaves produced in addition one leafy crown gall each, while three leaves produced two leafy crown galls each; the remaining seven leaves produced no leafy crown galls at all. Another group of leaves, nine in number, produced 54 globular crown galls, and only four leaves produced one leafy crown gall each. In another group of nine leaves 45 crown galls of the globular type were formed. Four of these produced one leafy

crown gall each; two other leaves produced two leafy crown galls each. Eight leaves in another group showed 24 globular crown galls; in addition, two of the leaves showed four leafy crown galls. In two smaller groups made up of five leaves, eight globular crown galls with two leafy crown galls were formed.

In all, 230 crown galls were formed at the notches. Of these, 199 were of the globular type without any indication of leafy shoots of any form. Thirty-one were of the leafy type, of which 12 were like axillary leafy crown galls and 19 were of the differentiated type. That is, in 48 counted leaves, with one-half of the notches inoculated, the globular crown gall without leaves or roots appeared 7.4 times more frequently than the leafy crown galls of either the differentiated type or the axillary bud type. A number of notches failed to develop crown gall of any form. The inoculation induced necrosis of the leaf in the region of inoculation.

I have studied the development of the notches of *Bryophyllum* leaves uninoculated and attached, that were growing on the same bench with the inoculated plants. The conditions which induced the notches of all the uninoculated plants to proliferate appeared later. My observations on detached leaves are in accord with Loeb (1918 *a*) on the position of the developing notches. Few apical and basal notches develop, although in my cultures I have seen apical notches form shoots. Loeb (1918 *b*) contends that attached leaves of *B. calycinum* which show sprouting notches are sick plants. The specimens I have under observation are not bent nor growing in pots. FIG. 4 shows a very young plant with numerous sprouting notches on lower leaves. It appears to be an actively growing plant. The conditions that induced the notches to develop in these uninoculated plants were apparently equally active in the inoculated plants also, for, as mentioned above, all these plants were growing on the same bench.

In TABLE 2, column 2 gives the number of notches in each of twelve leaves. Under column 3 is given the number of shoots that appeared on each leaf. Of 195 leaf notches of *Bryophyllum*, 106 produced shoots.

TABLE 2

UNINOCULATED NOTCHES OF LEAVES OF BRYOPHYLLUM CALYCINUM

| No. of leaf | No. of notches per leaf | No. of sprouting buds |
|---|---|---|
| 1 | 17 | 14 |
| 2 | 18 | 9 |
| 3 | 16 | 11 |
| 4 | 15 | 6 |
| 5 | 17 | 10 |
| 6 | 18 | 9 |
| 7 | 17 | 7 |
| 8 | 15 | 6 |
| 9 | 14 | 11 |
| 10 | 15 | 5 |
| 11 | 16 | 10 |
| 12 | 17 | 8 |
| | 195 | 106 |

It appears from these data that *Bacterium tumefaciens* does not stimulate bud development, even in the presence of conditions which favor it. *B. tumefaciens*, it appears, induces a neoplasm which offers mechanical obstruction to the transportation of fluids, which, in turn, calls forth bud proliferation, as shown in the rubber plant (Levine 1924). If bent stems induce partial interference in the conducting system, which is responsible for the development of shoots in the notches of leaves of *Bryophyllum calycinum*, as held by Loeb (1918 *b*), it appears to be reasonable to suppose that a disturbance induced by a mass of invading meristematic tissue may at least have a similar effect on these buds one in 8.4 chances.

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**Explanation of plate 10**

FIG. 1. Attached leaf of *Bryophyllum calycinum* inoculated with *Bacterium tumefaciens* showing crown gall and bud development similar to the axillary leafy crown gall resulting from the inoculation of an axillary bud.

FIG. 2. The leafy crown gall shown in FIG. 1 after growing in soil for two months.

FIG. 3. Globular crown gall at *a*. Differentiated crown gall showing small leaves growing out of crown gall at *b*.

FIG. 4. Young uninoculated *B. calycinum* plant showing developed marginal notches.

BRYOPHYLLUM WITH CROWN GALL

# INDEX TO AMERICAN BOTANICAL LITERATURE

## 1924

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